ENVIRONMENT

ABSTRACT:

The U.S. environmental industry is poised to support growth and preserve the environment, a process known as sustainable development. Despite only a small percentage of U.S. environmental businesses participating in the world market, the U.S. industry has the best technology in the world and already generates a trade surplus. With the world market expanding sharply, both the U.S. government and environmental industry must seize the opportunity to expand U.S. trade and proliferate U.S. environmental expertise, while simultaneously advancing U.S. security interests and supporting global sustainable growth. U.S. environmental businesses can simultaneously make a real difference in people's lives around the world, grow their companies, and support U.S. security. This paper shows how the U.S. environmental industry could increase its global competitiveness if U.S. national policies incentivized individuals and companies to move beyond regulatory compliance and if certain real and perceived barriers to conducting trade abroad were removed. Together, these require a new partnership between government and industry that is well worth the investment – a clean environment is good for business and good for life.

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Introduction.

The U.S. environmental industry is poised to support growth and preserve the environment, a process known as sustainable development. Despite only a small percentage of U.S. environmental businesses participating in the world market, the U.S. industry has the best technology in the world and already generates a trade surplus. With the world market expanding sharply, both the U.S. government and environmental industry must seize the opportunity to expand U.S. trade and proliferate U.S. environmental expertise, while simultaneously advancing U.S. security interests and supporting global sustainable growth. U.S. environmental businesses can simultaneously make a real difference in people's lives around the world, grow their companies, and support U.S. security. This paper shows how the U.S. environmental industry could increase its global competitiveness if U.S. national policies incentivized individuals and companies to move beyond regulatory compliance and if certain real and perceived barriers to conducting trade abroad were removed. Together, these require a new partnership between government and industry that is well worth the investment – a clean environment is good for business and good for life.

The Industry Defined.

The environmental industry is a highly fragmented and diverse collection of activities. It includes highly technical experts and blue-collar trash collectors as well as large public utilities and small-scale consulting firms. It is an industry concerned with the ancient problems of providing clean water and handling waste, but using cutting edge technologies to support human and environmental needs. Its impact is global, yet it concentrates on the U.S. market.

The environmental industry focuses on advancing sustainable development by reducing risk, enhancing cost-effectiveness, improving process efficiency, and creating products and processes that are environmentally beneficial or benign. The environmental industry includes all revenue-generating activities associated with: (1) compliance with environmental regulations; (2) environmental assessment, analysis, and protection; (3) pollution control and waste management; (4) restoration of contaminated property; (5) provision and delivery of water, recovered materials, and clean energy; and (6) technologies and activities that contribute to increased energy and resource efficiency, higher productivity, and sustainable economic growth.

There are 14 business activity segments, divided into three broad categories, based on the dominant source of revenue generation. See Table 1. Many of these activities fit within other, more traditional categories of economic activity monitored by the U.S. government. This intermingling with other industries complicates attempts to define and track the industry. The most powerful and promising sector of the industry – technologies transferred to other industries that improve environmental efficiency and avoid or reduce environmental damage – are not captured in the statistics shown here.

U.S. Environmental Industry		
Segment	**Description**	**1999 Revenues ($ billions)**
Environmental Services	*Obtains revenues by collecting fees for services rendered*	
Environmental Testing & Analytical Services	Provide testing of "environmental samples" (soil, water, air, & some biological tissues)	1.2
Wastewater Treatment Works	Collect & treat residential, commercial, & industrial wastewaters.	26.7
Solid Waste Management	Collect, process & dispose of solid waste	37.2
Hazardous Waste Management	Manage ongoing hazardous waste streams, medical waste, nuclear waste.	5.3
Remediation/Industrial Services	Provide physical cleanup of contaminated sites & buildings; provide environmental cleaning of operating facilities.	11.2
Environmental Consulting & Engineering	Provide engineering, consulting, design, assessment, permitting, project management, operations & maintenance, monitoring.	16.4
Environmental Equipment	*Obtains revenues from the sale or lease of equipment*	
Water Equipment & Chemicals	Produce equipment, supplies, & maintenance in the delivery & treatment of water & wastewater.	20.0
Instruments & Information Systems	Produce instrumentation for the analysis of environmental samples, & provide information systems & software.	3.2
Air Pollution Control Equipment	Produce equipment & technologies to control air pollution, including vehicle controls.	17.1
Waste Management Equipment	Produce equipment for handling, storing, or transporting solid, liqued, & hazardous waste.	9.7
Process & Prevention Technology	Provide equipment for in-process pollution prevention & waste treatment & recovery.	1.0
Environmental Resources	*Obtains revenues from the sale of resources or reclaimed materials*	
Water Utilities	Sell water to end users.	29.4
Resource Recovery	Sell materials recovered & converted from industrial byproducts & postconsumer waste.	14.4
Environmental Energy Sources	Sell power & systems in solar, wind, geothermal, small-scale hydro, & energy efficiency.	3.6

Table 1. U.S. Environmental Industry[i]

Current Condition.

Overall, the U.S. environmental industry is now displaying classic signs of a maturing industry. Signs include decelerating growth, heightened competition, growing sophistication among its client base, greater emphasis on marketing, consolidation of market share in larger players, and heightened merger and acquisition activity.[ii]

Economic Trends, Trade, and Productivity.

The industry has current annual revenues of about $205 billion, accounting for 1.4 million jobs in over 115,000 revenue-generating companies. In terms of both revenue and employment, the U.S. environmental industry is larger than many other industries, including aerospace, computer hardware, paper and allied products, petroleum refining, steel, textiles, and chemicals. The industry employs six times more people than motor vehicle and car body manufacturing and nearly equals the revenues of that sector. Municipalities represent the largest single component of the U.S. market. More than 80,000 units of local government acquire about $65 billion of environmental technologies annually. Approximately 95 percent of the businesses are considered small, with an average of 12 employees and annual revenue just below $5 million. Domestic growth in the industry is flat, in the 2-4 percent per year range, and investment is at its lowest level in 30 years – driven by the uncertainty of the U.S. stock markets and the continuation of regulatory uncertainty in the environmental industry. Furthermore, the industry is highly fragmented, represented by over 170 national trade associations.

The economic power of the industry is difficult to measure because so many of its products are integrated into other industry outputs and processes. In the 1970s, the U.S. market was driven by regulation that focused on clean up and "end of pipe" solutions; however, with the deregulation of utilities the market began to shift horizontally. In the 1990s, customers began demanding a wider range of products and services that were beyond "end of pipe" solutions. Customers sought solutions that offered competitive advantages, such as higher productivity, reduced waste of energy and materiel inputs, and greater in-process reduction of environmental residuals. For instance, the use of innovative technology such as satellite imagery to identify and resolve specific environmental problems through remediation are not captured under the current measures of the industry. These horizontal shifts in the market have blurred an industry that was once easier to measure, making it difficult to determine the true economic health of the industry. In fact, revenue estimates may be actually three times the Department of Commerce's current measures of the industry.[iii] Even so, the industry is still missing out on opportunities. The next few years will be pivotal in light of evolving domestic needs, strong competition for a static level of demand, challenge to develop and distribute new environmental technologies, and opportunities in the growing international markets.

The current global environmental market is valued at just over $520 billion per year. For developed countries, growth is flat – in the 2-4 percent range. Some key emerging markets are, however, growing rapidly. Growth in parts of Asia, Eastern Europe, and Latin America is 10 percent per year – creating enormous export opportunities. At just over $205 billion, the U.S. represents 39 percent of the global revenues and ranks number one in the world. It is almost twice the size of its nearest competitor, Japan. This year, U.S. exports of environmental technology goods and services will top $21 billion, producing a positive trade balance of $10 billion and creating about 170,000 jobs.

International Competitiveness.

Although the data indicate a strong, profitable U.S. industry poised to continue dominating the world market, a closer examination reveals that U.S. competitiveness abroad is weak in many segments of the industry. Of the 117,000 businesses engaged in the industry, only 4,300 are exporting goods and services.[iv] U.S. exports represent only

9 percent of environmental revenues compared to competitors' 15-20 percent.[v] Data indicates that, although revenue from exports is increasing, the U.S. share of the non-U.S. market is rising only modestly while the trade surplus is actually decreasing.[vi]

The U.S.'s biggest competitors are those developed countries with the most advanced policies and frameworks including Germany, France, the United Kingdom, and Japan.[vii] The U.S.'s strong technology and service industry provide an advantage in consulting and engineering as well as instruments and information systems. Germany, moving aggressively to capture a large market share, leads the world in exporting pollution abatement equipment. Japan, whose government promotes both pollution cleanup and prevention technologies, has taken the lead from the U.S. in air pollution control equipment exports. Having privatized over 70 percent of their water and wastewater industry, France and the United Kingdom currently dominate the international market for water and wastewater treatment technologies and services. The U.S. industry possesses sufficient technical capability to compete in these water related segments; however, it is unable to compete in the business and financial aspects since 70 percent of U.S. entities are still in the public sector where returning value is not maximized.[viii] This is of significant concern as water treatment and water utilities make up 30 percent of the global market and represent huge potential revenues. Additionally, many U.S. municipalities are considering using these foreign companies as they shift toward privatizing these segments of our own economy.[ix]

Factors that inhibit the U.S. from increasing its market share of business in other countries can be categorized in two areas:

Hampered Technology and Commercial Development. When the National Environmental Policy Act was passed in 1970, environmental regulations, and therefore the industry, were focused on remediation or clean up after pollutants were released. As the most polluted sites were cleaned and the industry matured, this industry has attempted to shift away from remediation to fulfill new customer preferences for abatement and prevention.[x] The products and practices that work toward prevention are considered the future of the industry. Despite some rapid growth in the prevention market, however, the vast majority of spending in the U.S. industry is still directed toward traditional remediation and "end of pipe" treatment technologies. Advanced technology needed to move the industry into the abatement and prevention phases is hampered by an outdated regulatory system, inconsistent regulations and enforcement, and a lack of financing needed to get technology into the commercial market.[xi]

1) Outdated Regulatory System. As a whole, pollution control regulations still reflect the "command and control" philosophies put in place early in the environmental program to dictate emission and discharge limits. Unfortunately, in addition to setting pollution limits, this format tends to also dictate or favor many existing technologies or processes. This structure causes existing technologies to gain certain monopolies and hinders innovation needed to move beyond "end of pipe" technologies to products and processes that allow customers to realize the advantages of abatement and prevention.

2) Inconsistent Regulations and Enforcement. Research and development is often aimed at technologies that meet or exceed current or anticipated regulations. As the past three decades have shown, however, regulations that drive the environmental industry have been frequently rescinded, altered, and inconsistently enforced. Additionally, state and federal regulations often differ as do regulations between states. These variations in

regulations deter anyone investing time, money, or other resources to develop or purchase new technologies. New equipment or processes can quickly become noncompliant or economically undesirable based on rapidly changing regulations or hollow enforcement. As a result, developers and consumers are more likely to stick with proven technologies that meet current standards.

3) Lack of Commercial and Government Financing. In addition to developers and customers, the financial community is wary of investing in the industry due to heavy regulations and vulnerability to rapid changes caused by political decisions. Risk is increased by the fact that permitting and enforcement officials have often been viewed as less inclined to grant waivers for new technologies, increasing fear of liability if new technologies do not meet required standards. Therefore, investments are often perceived as being too risky especially when considering the opportunity cost of capital in a growing economy.

Government investment is lacking for two reasons. First, although government investment in research and development (R&D) is higher than every country except Germany, the percentage of GDP devoted to R&D is far below those of foreign competitors.[xii] Although government funds are available for R&D, very little financial aid exists for the commercialization and marketing needed to bring new technologies to market. These funds are stopped to prevent the appearance that the government is competing with industry. As a result, many good initiatives are abandoned after the R&D stage before they are brought to market.

Obstacles to Conducting Business Abroad. In addition to an increasingly hampered environmental technology base, the high relative risk and difficulty in doing business abroad has hindered U.S. competitiveness overseas. Four major issues contribute to this reluctance. First, business development costs abroad are three to five times the costs in the U.S. This is a significant detractor since the industry is primarily made up of small and medium-size companies. These companies are least likely to find the financing or information necessary to cover the increased expenses or navigate through required rules and procedures. Second, smaller U.S. companies often find it difficult to compete with larger foreign firms that receive significant financial and informational support from the government. Third, many U.S. businesses are apprehensive about conducting business overseas due to the difference in culture, monetary systems, laws and regulations. It is often difficult for them to find the data and information needed to conduct transactions. Even if the information is found, many small companies prefer not to expend the effort or incur the expense and risk. Finally, few U.S. companies have found it necessary to do business abroad. Although markets and opportunities abroad are growing, the size of the domestic market and general health of the U.S. economy for most of the past decade have induced few to actively pursue overseas ventures.

Challenges.

The environmental industry is now at a crossroads. In the past, growth in the industry was driven by the need for compliance with regulations and focused heavily on the cleanup accomplished after the polluting occurred. Now, substantial compliance with existing regulations has been reached. Although the regulation-induced demand for the industry's products and services is eroding, there is a growing demand for high

productivity and sustainable growth. Yet, the industry as a whole, has been slow to adopt the creative and technologically innovative approaches necessary to meet these new demands. This reluctance is due, in part, to budget constraints, traditional thinking, and outdated regulations that prescribe a focus on post-pollution clean-up. For the U.S. environmental industry to remain viable and to grow, government and industry leaders must develop policies that encourage simultaneous economic growth and environmental protection. Environmental protection and pollution protection must become integral aspects of industrial processes.[xiii]

Industry leaders cite five major areas of action that companies must take, in concert with government, to ensure the environmental industry's future competitiveness.[xiv]

1. Offer new, value-added environmental products and services. Customers' adoption of new processes and methods that link environmental performance with overall business strategy are beginning to reshape demand for the products and services of the industry. Environmental companies must encourage this trend, with reinforcement by government agencies. The future competitiveness of the industry will center on its ability to deliver value rather than simply correct problems.

2. Reform government polices to stimulate the environmental market. Systemic change, not more experimentation, initiatives, and pilot programs, is critical. Government agencies are evaluating new policies that reward and encourage excellence in environmental performance. Some form of policy direction is essential to both benefit the environment and enhance national competitiveness. Industry leaders, however, do not argue for new rounds of regulations. Replacing "command and control" regulation with performance-based regulations and information-based mechanisms is the solution.

3. Revamp government environmental technology-related research and development (R&D) programs. Technology development resources should be shifted toward technologies that might contribute to a more sustainable economy. Environmental technology R&D resources should be increased for programs in which the government, federal, state, and local, facilitates R & D and product development by the private sector and nongovernmental organizations (NGOs). These steps would increase both related private-sector R&D and taxpayers' return on government R&D investments in the U.S., leading to new environmentally beneficial products and services.

4. Improve government/industry cooperation to expand environment-related exports. Greater cooperation on environmental exports will directly influence the ability of the U.S. industry to contribute to environmental gains worldwide.

5. Value the environment in national and international economic systems. The free exploitation of the environment has been imperfectly replaced by highly variable regulatory-based pricing. The opportunity and need for more effective government policies, not necessarily regulation, is nowhere more apparent than in the relationship between government and industry for the environment and the economy.

Outlook.

Under the market conditions of a mature industry, companies have little to differentiate themselves from each other and thus compete on price, typically bringing down profits. Once fed by pioneering governmental regulations and standards, the innovation that led to a surge in technology, engineering, and systems management must

be modified to remain competitive on both the domestic and foreign scale. The old, regulatory driven, "command and control" nature of the industry served a very useful purpose; it dramatically improved the environmental quality for the American public locally and nation-wide. Industry leaders believe, however, that it has been apparent for some time that traditional methods have passed the point of diminishing returns. They believe that our "….domestic system of environmental regulation hobbles the competitiveness of the U.S. environmental industry, increases environmental costs, and discourages the adoption of innovative solutions to environmental problems. Not only does each increment of new prescriptive regulation result in less "return" in terms of social benefit, in their view, but the environmental industry's dependence on government regulation to create customer demand has narrowed its competitive strategies, channeling its products and services *towards* the compliance objective and *away* from the core business of its customers."[xv] Without a fundamental change in government policy, industry will have to look to the international market for growth opportunities.

The global market for environmental programs exceeds the U.S. market by over 2.5 to 1 and is growing rapidly. Industry leaders say a partnership between government and industry is required to develop these global markets. The industry must provide products and services that are needed internationally. The government must improve coordination of U.S. export programs, work closely with international finance institutions, and help companies work together. The environmental industry must more actively advocate reforms in international business promotion and in global and domestic policies that affect the industry.[xvi] The outlook for the environmental industry, an industry at a crossroads, is still promising provided it shifts its focus to international applications ands the developing international markets. Water supply and wastewater treatment in developing nations, primarily in Asia, Latin America, and Central Europe, should be prime targets for U.S. export development – especially to compete on a global scale with French and British firms that currently enjoy a distinct competitive advantage in these areas.

Asia and the Pacific: Asia and the Pacific are facing serious environmental challenges. High population densities, continued rapid economic growth, and industrialization are likely to cause further environmental damage.[xvii] Water supply is a problem, with one in three Asians having no access to safe drinking water. Energy demand is rising faster than anywhere else in the world. Asia's trend toward populations in mega-cities is likely to increase environmental and social stresses. Countries are responding with domestic investment in water supplies and treatment, waste reduction and waste recycling. The environmental market (all 1998 figures) in the Philippines was over $600 million, in South Korea over $5 billion, in Taiwan over $5.2 billion, and in China over $10 billion.[xviii] Meeting the needs of this rapidly growing population and its resultant infrastructure requirements will provide tremendous opportunities to U.S. firms in the years ahead.

Latin America and the Caribbean: Two major environmental issues stand out in the region. First, nearly three quarters of the population are already urbanized, many in mega-cities (similar to the situation in Asia) where air quality threatens human health and water shortages are common. Second, the depletion and destruction of forest resources, especially in the Amazon basin, threaten bio-diversity. During the past decade, concern for environmental issues has increased, and many new institutions and

policies have been put in place. However, the lack of financing, technology, personnel, and training and, in some cases, the presence of large and complex legal frameworks provide the most common hindrances to implementing solutions.[xix] The Latin American environmental market reflects demand for a broad range of goods and services. From the largest to smallest, the subsectors include water utilities, solid waste management, water equipment and chemicals, water treatment works, waste management equipment, air pollution equipment, consulting and engineering, resource recovery, hazardous waste management, instruments and information systems, analytic services, and environmental waste-to-energy projects. Among all the environmental sub-markets, potable water, municipal sanitation services, and industrial wastewater treatment offer the best opportunities for U.S. environmental firms.[xx]

European Union (EU): The European Union (EU) is the United States' largest export market for environmental technologies, with U.S. exports expected to grow to $158 billion by 2005. The primary driver for environmental technologies in Europe is the EU's aggressive environmental policies. Since the early 1970s, the European Commission has enacted over 200 environmental directives that mandate and guide member states in enacting national legislation dealing with environmental issues. Since 1992, the European Commission has taken a broader approach, integrating sustainable development and economic development. Its main focus since then has been on water pollution control, solid and hazardous waste treatment, and air pollution control. The markets in Mediterranean countries, where environmental progress has lagged behind that in the northern region, are generally less saturated by domestic and other European suppliers. However, U.S. companies selling to any European country need to incorporate business strategies to compete with European suppliers that enjoy advantages of low or no tariffs, long-standing commercial relationships, and geographic proximity.[xxi]

Central and Eastern Europe (CEE): Although U.S. exports to CEE are expected to reach $18 billion by 2005, the U.S. currently has a small (about 5 percent) share of the CEE market.[xxii] Since the early 1990s, CEE governments have been enacting legislation to reverse the damage caused by decades of heavy industrialization and to bring their nations into conformity with EU environmental standards. Most of the success in this area is, however, due to curtailment of industrialization rather than new enforcement. More developed CEE countries have developed their own domestic environmental industries, supplemented for the most part by western European suppliers. Poland, the Czech Republic, and Hungary have made the most progress in environmental improvements. In all CEE countries, lack of financing is the primary obstacle to more aggressive and rapid progress in the environmental area. However, U.S. firms have an opportunity to gain a foothold in those markets through U.S. export assistance programs targeted specifically for that region. The United States, with $22 million of exports in 1999, is the fourth largest supplier of environmental technologies to Poland, behind Germany, Switzerland, and Italy. The best potential market for U.S. environmental exports is Hungary, where the United States is already the largest foreign investor with $5.5 million in 1999.[xxiii]

Africa: Poverty is a major cause and consequence of the environmental degradation and resource depletion that threaten this region. Major environmental challenges include deforestation, soil degradation and desertification, declining biodiversity and marine resources, water scarcity, and deteriorating water and air quality.

Although many African countries are implementing new national and multilateral environmental policies, their effectiveness is often low due to lack of adequate staff, expertise, funds, and equipment for implementation and enforcement. Although cleaner production centers have been created in a few countries, most industries have made little effort to adopt cleaner production approaches. However, some companies and even local enterprises have recently voluntarily adopted precautionary environmental standards.[xxiv]

Government Goals and Roles.

Many industry leaders believe the U.S. government must act to shape the market climate in which the environmental industry will compete. Reshaping the environmental industry will take more than just new government policy to stimulate demand for environmental products and services. A fundamental transformation is required for the U.S. environmental industry. This transformation will require a strategic partnership between government policy makers, environmental industry leaders, leaders of the environmental trade associations, academics, and customers. Priorities for this partnership must include implementing reform through a greater use of market-based instruments such as tax incentives to stimulate new investment in the market. Furthermore, this strategic partnership must look at policies and programs to effectively facilitate the development and distribution of new environmental technologies to the market. Another priority for this partnership must include refining the measurements for the industry to capture revenues generated from new technologies in the horizontally expanding market. This partnership must continue the momentum created by the Department of Commerce's Exports initiative to build markets and create demand, identify technology needs, remove trade barriers, and promote financing for overseas markets – including marketing the U.S. Export-Import Bank's loan and insurance programs to facilitate an expansion of opportunities for U.S. businesses overseas.

Environmental degradation in other parts of the world, particularly the loss of biological diversity, changes in global climate, the spread of pollutants, the careless use of toxic chemicals, and the decline of natural fish populations, directly impacts the U.S. Struggles over land, water, and other natural resources in the developing world contribute to instability and conflict, which may threaten U.S. security and trade interests. Many of these global environmental problems are concentrated in precisely those regions of the world the U.S. seeks to influence with its national security policy of engagement. With just under 40 percent of the world's market, the U.S. environmental industry has the expertise and experience to address these problems and simultaneously profit from these emerging markets. Both the U.S. government and the U.S. environmental industry should take advantage of this convergence of interests.

The U.S. environment industry must overcome its fragmentation to take advantage of this opportunity. With over 170 national level trade associations, the industry lacks a common voice, communication mechanism, and information sharing tools it needs to be more proactive around the world. An industry dominated by small businesses will have difficulty establishing these tools; government must help. The Department of Commerce should encourage the national trade associations to consolidate, and foster the development of information systems that will help the industry increase its exports. The International Trade Administration of the Department of Commerce already maintains a web-based system businesses can use to find international

opportunities.[xxv] This should be coordinated and integrated with a business to business partnering and communication system, similar to the Eureka system in Europe, that help small businesses find the partners.

The U.S. government agencies have many programs aimed at helping foreign countries with their environmental problems, and helping U.S. businesses compete. Department of Commerce, U.S. Agency for International Development, U.S. Export-Import Bank, and the Overseas Private Investment Corporation, all have environmental programs. These programs, however, are not coordinated with each other. The government should leverage and focus these efforts as part of our regional engagement programs within the national security strategy. The infusion of U.S. small business directly into overseas projects at the municipal level will provide tangible improvements in people's lives, greatly help mold favorable public opinion toward the U.S., and demonstrate the strength of free market entrepreneurship and global trade. Local governments and people are less likely to view small businesses working on local environmental problems as threatening, or as the 'arrogant Americans trying to take over.' The U.S. should make better use of the environmental industry's expertise to advance our national security interests by coordinating and focusing the various U.S. programs into targeted areas of concern, such as Russia and China, and help businesses take advantage of international agency programs.

Domestically, it is time to move beyond "command and control" regulation. Regulation is a necessary part of environmental policy, but it may be reaching the limits of its capacity to improve environmental conditions effectively. The government should emphasize programs that encourage businesses and industries to prevent pollution, reduce or eliminate waste, and adopt principles of eco-efficiency. The National Research Council points out that, "the environmental problems of today are often difficult to diagnose and treat; they cross state, national, and international boundaries; entail difficult tradeoffs; and sporadically present unpleasant surprises."[xxvi] Relying simply on regulatory solutions will no longer address the complexities of environmental protection.

Implementing a partnership between federal, state, and local governments with business and industries in the private sector is fundamental to promoting and adopting beyond-compliance environmental management systems. Studies undertaken over the past decade generally conclude that the success of pollution prevention programs depends on developing a deeper understanding among political and legislative leaders and regulatory personnel at the federal and state levels of "best practices" in the private sector to achieve eco-efficiency. It is equally important to motivate business leaders to adopt beyond-compliance environmental management systems.

Public, private, and nonprofit organizations in the U.S. are looking for relief from federal command-and-control regulations for numerous reasons, including: regulations are numerous, complex, and frequently amended; regulations are punitive rather than incentive-driven; the bureaucratic process is slow, making it difficult for government to stay ahead of environmental threats; regulations result in a uniform set of standards that are not flexible enough to address variations in industry conditions and local needs; and the command-and-control approach reinforces an adversarial relationship between government and the private sector that subjects regulatory changes to legal challenges.

The U. S. General Accounting Office concludes that although the current system of environmental regulation in the United States is the most advanced in the world, its

volume and complexity "often results in conflict and gridlock." Between 1970 and 2000, the federal government created more than 11,000 pages of environmental regulations resulting in more than $1.5 trillion in compliance costs for industry.[xxvii]

To the extent that harmful emissions and wastes can be removed from products and manufacturing processes, companies will save money, increase their efficiency, improve the quality of the products they make, and enhance customer satisfaction. Cleaner production will result in cost savings through energy and water conservation, materials substitution, and recycling and reuse of waste materials.

Finally, the federal government must refocus its efforts in technology development. U.S. environmental technology development comes from both private and public sectors, but the Federal government provides the dominant source of funding. In 1999, the U.S. government spent roughly $4 billion on environmental technology. In contrast, the private sector, consisting mainly of small and medium-size businesses, spent several million dollars on development in 1999, the lowest total in over 30 years.[xxviii] It would be surprising to find government funding on the rise. Therefore, to increase technology investment there must be improved participation from the private sector. Thus, the two major government priorities for environmental technology reform should be: 1) improving the efficiency and success of government-funded programs, and 2) helping the private sector increase investment in environmental technology.

There are several improvements the U.S. government can make to improve the success rate of publicly financed environmental projects. The first involves setting priorities. Because there are hundreds of diverse federal programs, the nation's most critical technology needs seem to be diluted by the practice of spreading dollars out across so many areas and agencies. The federal strategy seems to be this: expose viable technologies using a shotgun approach to target as many environmental problems as possible, then leave it up to industry to finish development and find suitable markets for their products. A success rate of only 10 percent shows that this approach is not successful. Companies need consistent funding throughout a product development cycle to help them increase their chances of successfully bringing their products to the market. A better approach would be to dedicate a portion of the environmental budget to concept exploration and research, and another portion to vetting out viable concepts, funding the advanced development of these concepts, and then helping companies bring their projects to market. Of course, this would mean fewer good ideas would receive money for concept exploration. On the other hand, projects deemed viable would have a better chance of being successful.

To assist in establishing technology priorities, other nations, most notably Japan, work closely with industry to increase the success rate of public investment. This is in contrast to the U.S., which lacks the ties between government and private sector non-military R&D. In fact, over the last two decades over $100 billion was spent on environmental projects with little direction or input from the private sector.[xxix] Closer collaboration between federal and state governments and industry could help in identifying and prioritizing critical environmental and industrial needs to maximize limited resources. Collaboration is equally important within the federal government, especially when several government agencies are providing funding to environmental projects. Without coordination, opportunity exists for duplication and redundancy of programs. Within the federal bureaucracy, however, there does not appear to be a central

coordination and decision body to set priorities and approve projects laterally across agencies. The federal government should establish an environmental technology project office within the EPA or Department of Commerce to gain input from industry, prioritize research efforts, coordinate funding, and shepherd promising technologies to market.

Essays on Major Issues.

KYOTO PROTOCOL

Vincent G. McDade

The U.S. along with 38 other countries agreed to the Kyoto Protocol at the United Nations Framework Convention on Climate Change in December 1997 in Kyoto, Japan. This international environmental agreement calls for the major industrial economies, such as the U.S., Canada, Europe, and Japan to reduce their collective emissions of six greenhouse gases by an average of 5.2 percent from the 1990 levels by 2008-2012. The U.S. goal was set at 7 percent below 1990 levels, which amounts to an estimated 550 million metric ton cutback in carbon dioxide emissions relative to the 2010 projected amount.[xxx] Achieving such reductions is highly unlikely, however, considering the Department of Energy estimates that predict U.S. emissions will be 40 percent above the Kyoto target by 2010.

Global Warming

It is widely believed that rising levels of greenhouse gases are expected to cause global climate change. The earth's climate is driven by a continuous flow of energy from the sun. Some of this energy is sent back out into space in the form of infrared radiation. Greenhouse gases in the atmosphere block infrared radiation from escaping directly from the surface into space. The main greenhouse gases are water vapor, carbon dioxide, ozone, methane, nitrous oxide, and chlorofluorocarbons (CFCs). Apart from CFCs, all of these gases occur naturally and make up less than 1 percent of the atmosphere. The natural greenhouse effect they produce keeps the earth 30 degrees warmer than it would otherwise be.[xxxi] As a direct result of human activity, the levels of all key greenhouse gases, with the exception of water vapor, are rising. The thicker blanket of greenhouse gases is reducing energy loss into space and resulting in global warming.

Climate models predict that the global average temperature will rise by about 2 degrees Celsius (3.6 degrees Fahrenheit) by the year 2100 if current emission trends continue.[xxxii] The full effects of global warming are uncertain. Predictions include rising sea levels, changes in the frequency and intensity of extreme weather events such as storms and hurricanes, increases in precipitation patterns, and other rapid and unexpected climate transitions affecting agriculture, food and water supplies. Some experts predict significantly adverse human health results from climate change. Based on current trends, carbon dioxide concentrations are predicted to be double pre-industrial levels by 2030 and triple those levels by 2100. Total emissions would need to decrease to about 30 percent of their current level in order to stabilize the level of carbon dioxide in the atmosphere at double the pre-industrial level.[xxxiii]

Tackling the Problem

The international community decided to tackle this challenge through the 1992 climate change convention. The convention, now with 170 members, seeks to stabilize atmospheric concentrations of greenhouse gases. Member countries are committed to reducing emissions by developed countries to 1990 levels. The convention requires countries to limit emissions, gather relevant information, develop strategies for adapting to climate change, and cooperate on research and technology.

In 1997, 39 members (mostly developed countries) of the convention agreed to the Kyoto Protocol requirements. The Protocol calls for reductions of carbon dioxide, methane, nitrous oxide, hydroflourocarbons, perflourocarbons, and sulfur hexachloride. Carbon dioxide is responsible for over 60 percent of the increases in greenhouse gases and represents 85 percent of the U.S.'s emissions of these gases.[xxxiv] Fossil fuel combustion, mainly resulting from power generation, is the major source of this carbon dioxide.

Although 84 countries have signed the Protocol, nearly three years after the initial negotiation in Kyoto and subsequent negotiations focused on how to implement the protocol, the Kyoto Protocol is yet to be ratified by any of the key countries. Ratification is not likely by any of the industrialized countries in the near future.

Opposition

From the beginning, there was strong opposition in the U.S. to the Protocol. The Senate has overwhelmingly rejected ratification of the treaty, because the treaty fails to require mandatory reductions by most developing nations. President Bush, throughout his campaign, expressed his opposition to the Kyoto Protocol and, at the end of March, 2001 announced that the Kyoto treaty was "dead." The Administration has said it has no interest in implementing the treaty. The Administration believes the Kyoto Protocol is significantly flawed and that continuing to invest efforts and resources into fixing it would be futile. Although no other major industrial country has ratified the Kyoto agreement, allies are angered over the U.S.'s unilateral move to withdraw from it.

European Union leaders have written to President Bush urging talks to reach accommodation on a global warming treaty. German Chancellor Gerhard Schroeder was scheduled to talk with President Bush about the Kyoto agreement when the U.S. announced its decision to withdraw. The U.S. decision to pull out was taken as a serious affront in Japan, which takes pride in having hosted the negotiations that led to the accord.[xxxv] The U.S.'s response has promoted harsh commentary across Europe that the United States is "behaving like an arrogant superpower that places itself above the need to make economic sacrifices for the benefit of the world's environment."[xxxvi]

The Bush Administration has antagonized many of America's closest friends in Europe and Asia by summarily rejecting the Kyoto agreement on global warming. A top British official summed up the sentiments of many allied leaders, complaining that the United States was sitting in "glorious isolation."[xxxvii]

Though the President has stated that global warming is a serious issue and has committed the administration to continued engagement in international negotiations on ways to address climate change, the challenge will be to develop a new approach – less onerous to the U.S. economy – and to do so in cooperation with our allies. The administration now faces the problem of repairing international relations along with developing a global policy for addressing climate change.

Policy Proposal

The Administration must work in a cooperative fashion with all the stakeholders if it is going to be successful in addressing both the issue of climate change policy and reparation of international relations. The U.S. cannot just participate in stopping global warming; it must take the lead. In so doing, however, the U.S. should not continue to alienate our allies by failing to consult with them. The Bush Administration must develop climate change policy that results in both U.S. and global economic growth and the eventual stabilization of carbon dioxide concentrations in the atmosphere. Climate change policy must be based on hard science, improved climate change models, and global participation. Policy must be developed in consultation with all stakeholders: EPA, industry, environmentalists, and the international community. In addition, the State Department should play a significant role in this undertaking.

U.S. policy must include both internal and global initiatives. The U.S. should be proactive by leading a new realistic international agreement that considers economic growth and global participation. Globally, the U.S. should:

- Continue to fund and promote research on climate change models (The Senate already approved a measure to provide $4.5 billion in funds for climate change programs over the coming decade.[xxxviii])
- Consider developing of climate resistant strains of food grains[xxxix]
- Consider transferring clean-development technology to less developed countries

In order to demonstrate our commitment to the rest of the world we must openly practice what we preach. Internally, we must:

- Establish a responsible energy policy (Electric power plants emit 40 percent of the U.S. carbon pollution.):
    - Retire or repower inefficient outmoded power plants
    - Increase the energy efficiency of U.S. homes and businesses
    - Increase reliance on renewable fuels and natural gas, decreasing our dependence on dirtier fossil fuels (coal and oil)
- Utilize already available and cost-effective processes and technologies to reduce carbon emissions now, while research into undeveloped technologies continues
- Adopt legislation addressing fuel efficiency:
    - The Administration and Congress could consider tax credits or incentives to promote efficiencies
    - Raising automobile fuel economy standards (Using existing technology could save tens of millions of barrels of oil over the next decade.[xl])

Conclusion

Establishing realistic international and domestic climate change policies to address global warming is imperative to our national security and our global competitiveness. By correcting past errors and re-examining current possibilities regarding environmental stewardship, the U.S. can regain the political credit it needs. The U.S. should establish environmental practices and policies consistent with our national security strategy, considering their impact to our economy, military security, natural resources, and our domestic as well as international political obligations. Our

national security dictates that we address environmental security worldwide and that we do this in cooperation with our allies. In a finite world, where global security is at issue, the environment and how it is affected cannot be determined in a vacuum. International cooperation is imperative. The U.S. must engage and lead in the development of global climate change policy that results in both U.S. and global economic growth while stabilizing greenhouse gas emissions. Participation and leadership in a collective agreement is imperative if the U.S. to repair allied relationships and the world is to succeed in its fight against global warming.

INFORMATION TECHNOLOGY AND THE ENVIRONMENT

Tracy Tynan

Human beings have always had the need to provide themselves with drinking water and to dispose of their waste. Engineering feats, such as the aqueducts of Rome or the marvel of nuclear power, have aided man survive against nature. But, at what price? The use of fossil fuels helped usher in the industrial age and enabled widespread use of plastics, petrochemicals, automobiles, and a host of other goods that have had a negative impact on much of the earth's natural environment. As the planet became more crowded and industry grew, new treatment technologies helped detoxify an increasingly polluted environment. In Philadelphia, on April 7, 1778, Benjamin Franklin is credited with the following simple response to a question by his fellow city dwellers in regard to the poor state of living conditions: "Man is a tool-making animal."[xli] Franklin, in a few words was able to sum up the ability of man to overcome problems of our own creating. In the U.S., the last century has seen industrial development grow at such a pace that government regulations became necessary to manage and maintain our balance with the environment.

Between 1996 and 1998, the Gross Domestic Product of the U.S. increased nearly eight percent, but energy use increased less than one percent. This decelerating growth in energy use is very good news, because energy production and use are responsible for a large fraction of the emissions leading to urban air pollution. In fact, this source accounts for 85 percent of the gasses the U.S. produces impacting climate change. If energy use had grown in proportion to the economy, U.S. production of greenhouse gasses would have been 100 million tons of carbon higher. For a sense of scale, 100 million tons of carbon is the amount produced annually by 70 million new cars.[xlii] How is it possible that the economy could grow without a proportional increase in energy use and associated pollution? The answer has a lot to do with the explosive growth of information technology.

First, information technology businesses have themselves been major drivers of economic growth, and their value-added is primarily in the form of manipulating ideas, not energy and materials. More than 40 percent of U.S. investment in new equipment during the past decade has been in the form of information devices: computers, communications equipment, fax machines, etc. Further, more than a third of all economic growth in the U.S. since 1995 resulted from information technology enterprises.

Second, information technology has redefined the way virtually every product and service in the economy is designed, produced, and operated. As a result, our economy is growing not so much by adding more resources but by being increasingly clever about the way we use resources. Technologies that minimize waste or prevent pollution are in higher demand than those that treat waste at the "end of the pipe."[xliii] This will be especially true in developing markets, such as Asia and Eastern Europe, where environmental protection is currently seen as unaffordable by a majority of enterprises. In the U.S., where emphasis is traditionally placed on meeting regulations, the next generation of technologies will have to achieve the same or better results at a lower cost. More than two thirds of U.S. energy is used in residential and commercial buildings, automobiles, trucks, and other transportation systems. Therefore, the greatest potential benefit of information technology on the environment will not occur in the manufacturing sector, but in homes, offices, cars, appliances, and other devices we use everyday.

Information Technology Advancements

Four broad categories of information technology advancements affected the environmental technology industry: intelligent production processes, intelligent product design, intelligent product operation, and the blossoming of e-commerce.[xliv]

Production Processes: Intelligent production processes result from the computer-assisted design of production facilities coupled with precise control of operations during production made possible by inexpensive sensors and automated controls. Production systems that waste material are no longer profitable. Computer simulations mean that complex production systems are available for review before a system is purchased. Specifics such as costs, material use, and the expected environmental emissions of design options are now available to maximize all aspects of a proposed system. Once in operation, low cost sensors throughout a plant, coupled with communications networks and computer assisted controls, can ensure efficient and safe operation. Modern production systems can have tens of thousands of individual microprocessors embedded in them, controlling valves, measuring temperatures, sensing the color of fluids, and performing other tasks. These devices linked together, create a kind of nervous system capable of reacting intelligently to local or plant-wide problems.[xlv]

Precise control is essential to reducing environmental footprint. Large amounts of waste material are almost always a sign of inefficiency and poor process design and operation. With precise controls, material is not wasted because a chemical process is not balanced or because poorly made parts must be discarded. Controls are particularly important when an abnormal situation occurs. Had improved precision control technology been available and used in the late 1970's, the horrific Three Mile Island environmental disaster might have been prevented. Accurate controls can ensure a plant is operating safely and at peak efficiency, even when an abnormal situation occurs.

Product Design: Automobiles, home appliances, office equipment – virtually all of the products in our lives – are much kinder to the environment, thanks to the information technology used to design them. Modern design software and simulation tools mean everything from jet aircraft to beer cans can be engineered in a way that cuts unneeded use of materials and reduces waste. The Boeing 777, known as the "paperless airplane," serves as a benchmark for future aviation designs. Boeing used sophisticated tools to optimize the design of the entire aircraft by placing structural strength where it was needed and cutting weight were not needed.[xlvi] Thanks largely to improved design

technology, a pound of aluminum today can make 33 aluminum cans, up from 22 cans in 1972. Design improvements and improved alloys mean that the Sears Tower could be built today using 35 percent less steel than was used during its construction in 1974.[xlvii] Industry experts suggest similar savings may be possible by optimizing steel use in cars. These computer enhanced design techniques are playing a critical role in controlling U.S. requirements for raw materials.

Modern automobiles have 20-90 microprocessors. Among other things, these microprocessors provide precise control over the performance of automobile engines and emission control systems. Advanced control systems are particularly critical for the sophisticated new hybrid (fossil fuel and battery) and fuel cell technologies being developed. These new hybrid automobiles are predicted to increase fuel efficiency by as much as three times. Efficient operation of these vehicles will require adjustments every thousandth of a second – an incredible feat given the state of microprocessor sophistication just a few years ago. [xlviii]

Product Operation: Information technologies also provide key tools for ensuring efficient operation of products after they are produced, thereby minimizing their environmental impact. A typical modern passenger aircraft uses 21 gallons of fuel per minute. Continued improvement of designs should cut fuel use by 20 percent by 2010. Projections call for a 50 percent reduction by 2050. Trip times have been optimized by on board computers coupled with the Global Positioning Satellite system.[xlix] This means quicker trips in the air and fewer delays on the ground as well as fuel savings amounting to 8-18 percent. Continuing the transportation example, UPS, Federal Express, and others use control systems to dispatch each truck in a way that cuts the total time and fuel used to move packages around a city. Trucks can change routes quickly in response to new delivery needs or local traffic. Similar systems are in use on mass transit systems to include the METRO in Washington, DC. METRO is in the initial phases of completely automating the conductor position. In the future, a central control system will control speed, duration of stops, door open times, etc on the entire METRO system. METRO officials believe this improvement will mean safer operations, less delay, increased fuel efficiency (projections range from 5 to 12 percent), and fewer personnel on the payroll.[l]

Residential and commercial buildings use about a third of all U.S. energy and more than two thirds of all electricity. Information systems are key to improving the efficiency of buildings and building components. Simple, readily available improved heating and cooling controls can provide 10-15 percent in savings. Nearly 15 percent of U.S. electricity is used for lighting. Automated dimmers are effective for reducing artificial lighting requirements while maintaining adequate lighting levels. Elevators use as much as 5-8 percent of a building's energy. Improved computer based controls designed to reduce the waiting time for customers, can also cut energy needs by 5-20 percent.[li]

E-commerce and the Environment: In 1998, 28.6 million American households had gone on-line. By 2003, that number is projected to reach 52.8 million.[lii] The Internet is rapidly become the medium of trade. Though much of the volume of trading that occurs over the Internet is between businesses, ordinary shopping by consumers is rapidly gaining in importance. According to the Department of Commerce, between October 1998 and March 1999, 56 million purchases were made over the Internet – four times more than the previous year. Projections indicate that by 2002, on-line retail sales

may reach $40 to $80 billion.[liii] E-commerce will reshape our lives, transforming everything from the way we shop for necessities to how we pay our bills and plan our vacations. Product prices are more easily compared, and buyers gain a great deal of power. As stunning as these changes are for the consumer, the most dramatic shift will come in how the geography of business will change.

The product supply chain, made up of companies involved in the distribution of goods from manufacturing plants to retail outlets, comprises an enormous number of links. In the U.S., approximately 245,000 such intermediary businesses, from wholesalers to brokers and commercial agents, operate establishments nationwide.[liv] Companies able to accurately predict consumer demand at the retail level can reduce excess inventories by replenishing the items they sell with the right quantity at the right time at the right locations. This could decrease the space needed to store products waiting to be sold, thereby minimizing the environmental impacts of warehousing and reducing the energy needed for heating, cooling and lighting. For example, Home Depot has virtually eliminated the need for warehousing. Eighty five percent of its merchandise is moved directly from manufacturers to its retail stores. Sales associates walk the aisles, electronically recording orders for products that need to be restocked. In fact, 80 percent of the orders are sent via the Internet directly to the company's manufacturers.

Manufacturers invest large amounts of money in the design of packaging intended to attract attention and thus spur consumption of the product. The environmental costs of packaging are enormous. In the U.S., packaging accounts for one-third of the municipal solid waste generated by consumers. Even if all this material were recycled, the energy and labor involved in collection, sorting, and processing remains a huge municipal expense. When products are sold via the Internet, the marketing functions of packaging become less significant. Instead, the computer image is what communicates a product's qualities and attracts the consumer's attention. In addition, since the backbone of on-line shopping is shipping efficiency, e-commerce creates incentives to reduce the size and weight of product packaging. As a result, companies may find it advantageous to reduce the quantity of the materials used to package their products.

Environmental Impacts of Information Technology

As demonstrated in the many examples described previously, information technologies are having a favorable impact on the economy while reducing the demand for energy. However, the growth in the use of information equipment has been so rapid that the production and use of information technologies have themselves become major sources of pollution. For example, the manufacturing of semiconductors requires a number of solvents and chemicals that can harm the environment. The semiconductor industry has found ways to use process controls and new materials to minimize the problem. Processes that ensure the parts require no cleaning eliminate toxic solvents once used to clean circuit boards.[lv]

Computers, information technologies, and other sophisticated information equipment are becoming the largest source of growth for electricity demand. Since power consumption often increases as computer and communication speeds increase, this can cause concern as consumers push for even faster communication and computer speeds. The heat generated by this high power use is a major problem for system designers, and power reduction has been a major goal of designers of chips, computers, and communication networks for some time. The use of low voltages coupled with

control systems that turn off disk drives, monitors and other devices when not needed have the potential to cut energy use in the typical desktop setting by 45 percent. Finally, the devices embedded in television monitors, telephones, and other equipment to provide "instant on" capability consume considerable amounts of power even when the equipment is not being used. These "standby losses" now account for 5-15 percent of residential energy use. Recently, however, technology came to the rescue and, for less than a dollar per unit, cut losses by a factor of 20.

Conclusion

Information technology allows ideas and innovations to spread worldwide with relative ease. Worldwide access to the benefits of advanced, efficient production methods and products is essential if the world is to support billions of people in prosperity. Virtually all of the growth in worldwide emissions and other critically damaging pollution in the next century are likely to come from developing nations. Information technology can play an essential role in providing advanced education and training for people worldwide, and can help the world's businesses shift rapidly to efficient, clean production.

Finally, information systems could facilitate a national and possibly worldwide dialogue about policies needed to ensure that growth is consistent with an improved environment. Franklin's words of long ago still ring true -- "man is a tool-making animal." Information systems have the potential to build a more prosperous future. In fact, they may be our best hope for sustaining an advanced economy without endangering the natural world on which our survival ultimately depends.

Conclusion.

In summary, the environment has become an issue of growing importance for the U.S. and the world at large. The recent decision by the Bush administration not to seek ratification of the Kyoto Protocol may have had a positive effect by further raising public awareness and concern for the fragile nature of the environment.

Problems with national security implications should be addressed through a comprehensive national plan. The national environmental plan should balance economic growth with environmental protection, and thus promote sustainable development. It should enhance the current regulatory scheme with incentives for developing and implementing new technology, measures to promote conservation and efficiency, and schemes to strengthen the global competitiveness of the industry. The plan should be supported by a focused public education campaign to highlight the importance of the environment as a source of economic power and to ease the pain of increased prices for goods and commodities, such as electricity and gasoline.

In addition to strengthening enforcement of current regulations, our various jurisdictions must move toward consistency in order to make our internal borders more transparent. But, the real key to improving our environment is to provide incentives for businesses to move beyond mere compliance with regulations. Moreover, just as Quality Management Systems worked to focus attention on product quality, Environmental Management Systems can work to include consideration of environmental impacts in all production, distribution, and disposal processes.

To encourage innovation, we must stop telling industry how to meet the regulatory standard. A partnership of government, industry, and NGOs representing the public interest can work together to build solutions which are effective, cost efficient, and acceptable to the public.

In order to stimulate consistent demand for environmental products and services and to create incentives for continuous environmental improvement in the regulated community, policies must be instituted to value the environment in national and international economic systems. Internalization of the costs of wasted resources, pollution, and environmental degradation into the everyday calculations of individual businesses will enable the free market to accurately reward environmental excellence and punish environmental malfeasance.

Policies that generate predictable economic consequences for unsustainable behavior will ensure that investments in environmental improvement will be continuous until a maximal point of economic and environmental sustainability is reached. While today's markets do little to account for environmental degradation and unsustainable resource consumption, future economic policy, stimulated by international environmental agreements and trade concerns, must focus on these issues. The fundamental adjustment of our accounting system to value the environment can serve as the framework of sustainable economic policies and rational environmental policies.

If it was a challenge of the past 25 years to reverse environmental degradation, the challenge of the next 25 years is to construct the foundations for a sustainable national and world economy. The environmental industry, together with government, must formulate a business-type strategy that incorporates a forward thinking vision for the future. Corporations and industries rarely remain on top or gain a leadership position in a particular market relying solely on short-term tactics. The essence of business strategy is a long-term, coherent vision. The industry must be devoted to creating this vision of sustainable economic policy for the companies, for the collective environmental industry, and for the good of the environment.

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[i] All environmental industry data used in this paper, unless otherwise stated, are from the Environmental Technologies Industries (ETI) office of the U.S. Department of Commerce and Environmental Business International, Inc. of San Diego, CA (EBI) February 2001 survey. EBI, an independent business research firm, has defined, classified, and quantified the environmental industry since 1987, serving as a de facto census taker for the U.S. environmental industry. Their data is routinely used by the U.S. Department of Commerce and the Environmental Protection Agency. Table is from their web-site: http://environmental-industry.com/ebj/defofeninseg.html

[ii] David Berg and Grant Ferrier, Meeting the Challenge: U.S. Industry Faces the 21st Century: The U.S. Environmental Industry - Executive Summary U.S. Department of Commerce, Office of Technology Policy (September1998), 8.

[iii] David Scott Smith (Lecture on EPA Office Policy, Economics and Innovation, and Environmental Technology at the Industrial College of the Armed Forces, March 15, 2001).

[iv] Department of Commerce/International Trade Administration, U.S. Industry and Trade Outlook 2000, (Springfield, VA: McGraw-Hill, 1999), 20-1.

[v] Berg and Ferrier, 20.

[vi] Table 2: U.S. Environmental Trade Balance (1999).

	1993	1994	1995	1996	1997	1998	1999
Global Market ($B)	423	440	453	463	473	485	499
U.S. Market ($B)	160	167	172	174	177	182	189
U.S. Exports ($B)	9.4	11.1	14.2	15.6	18.2	18.8	21.3
U.S. Imports ($B)	No data	5.5	6.6	7.7	9.0	No data	No data
U.S Share of non-U.S. Markets (%)	3.6	4.1	5.1	5.4	6.1	6.2	6.9
Trade Surplus ($B)	4.6	5.3	7.6	7.1	8.5	8.0	7.3

Source: Environmental Business International, Inc., San Diego, CA

[vii] Table 3: Relative Competitiveness of Environmental Industries.

	U.S	Germany	Japan	F&UK	Developing
EQUIPMENT					
Water Equip & Chemicals	G	G	GE	GE	MP
Air Pollution Control	OG	E	E	O	MP
Instruments & Info Systems	E	G	G	O	P
Waste Mgmt Equipment	G	GE	OG	O	OM
Process & Prevention Tech	P	P	M	P	P
SERVICES					
Solid Waste Mgmt	G	OG	OM	EG	MP
Hazardous Waste Mgmt	G	O	O	OG	P
Consulting & Engineering	GE	OG	M	OG	MP
Remediation/Industrial Services	G	O	M	OM	P
Analytical Services	G	O	O	O	MP
Water Treatment Works	MP	M	MP	GE	MP
RESOURCES					
Water Utilities	MP	MP	P	GE	MP
Resource Recovery	O	OG	O	O	MP
Environment Energy	OG	OG	OG	OG	P

Source: Environmental Business International, Inc., San Diego, CA

E = excellent, G = Good, O = OK, M =Mediocre, P =poor

[viii] Berg and Ferrier, 14.

[ix] Ibid, 20-6; idem, U.S. Industry and Trade Outlook 2000.

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[xi] Ibid, 17-24.

[xii] Ibid, 13.

[xiii] Commerce Issues First Report on the U.S. Environmental Industry, 22 October 1998. Retrieved from http://www.ta.doc.gov/prel/pr10221998.htm on 16 March 2001.

[xiv] Berg and Ferrier, 10.

[xv] Ibid, 22.

[xvi] Ibid, 35.

[xvii] United Nations. U.N. Environment Program, Division of Environmental Information, Assessment, and Early Warning. Global Outlook 2000. Nairobi, Kenya: Chapman Bounford & Associates (1999), 7.

[xviii] U.S. Department of Commerce ITA Industry and Trade Outlook, 20-15.

[xix] U.N. Environment Program Global Outlook 2000, 9.

[xx] U.S. Department of Commerce ITA Industry and Trade Outlook, 20-16.

[xxi] U.S. Department of Commerce ITA Industry and Trade Outlook, 20-15.

[xxii] U.S. Department of Commerce ITA Industry and Trade Outlook, 20-17.

[xxiii] U.S. Department of Commerce ITA Industry and Trade Outlook, 20-18.

[xxiv] U.N. Environment Program Global Outlook 2000, 6.

[xxv] http://infoserv2.ita.doc.gov/td/Infrastr.nsf

[xxvi] National Research Council, Strengthening Science at EPA, (Washington DC, National Academy Press, 2000), 1.

[xxvii] Kathi Futornick, Total Quality Environmental Management: Managing Corporate Change, (Boca Raton, FL: Lewis Publishers), 57-76.

[xxviii] David Scott Smith (Lecture on EPA Office Policy, Economics and Innovation, and Environmental Technology at the Industrial College of the Armed Forces, March 15, 2001).

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[xxxiii] Ibid.

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[xxxvi] Ibid.

[xxxvii] Alan Sipress, "Aggravated Allies Waiting for US to Change Its Tunes", The Washington Post, 22April 2001, 4.

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[xl] Anonymous, "Bush Opposes Kyoto Protocol", Natural Resources Defense Council.

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[xlii] Allen Hammond, "A Vision: A World that is Genuinely Better, not just Wealthier," CISP.org (October 1999) 8 pp. Online. Internet. 8 March 2001.

[xliii] Henry Kelly, "Information Technology and the Environment: Choices and Opportunities," CISP.org (October 1999) pp 8. Online. Internet. 7 March 2001.

[xliv] Allen Hammond, "A Vision: A World that is Genuinely Better, not just Wealthier," CISP.org (October 1999) 8 pp. Online. Internet. 8 March 2001.

[xlv] Text: The Emerging Digital Economy II: US Department of Commerce. (3 September 1999) 26 pp. Online. Internet. 8 March 2001.

[xlvi] Allen Hammond, "A Vision: A World that is Genuinely Better, not just Wealthier," CISP.org (October 1999) 8 pp. Online. Internet. 8 March 2001.

[xlvii] Text: The Emerging Digital Economy II: US Department of Commerce. (3 September 1999) 26 pp. Online. Internet. 8 March 2001.

[xlviii] Ibid

[xlix] Ibid

[l] Text: Metro Worker Interview: Interview conducted 21 February 2001.

[li] "Intergovernmental Panel on Climate Change, Aviation and the Global Atmosphere," Cambridge University Press (Fall 1999) 30 pp. Online. Internet. 8 March 2001.

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[liii] Text: Facts about Environmental Technologies: US Department of Commerce. (Third Quarter 2000) 46 pp. Online. Internet. 17 February 2001.

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